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IS 3608-2 (1987): Glass Alcoholometers, Part 2: Glass Alcoholometers with Thermometer (Thermo-alcoholometers)  
[CHD 10: Glassware]

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IS : 3608 ( Part 2 ) - 1987

*Indian Standard*  
SPECIFICATION FOR  
GLASS ALCOHOLOMETERS

PART 2 GLASS ALCOHOLOMETERS WITH THERMOMETER  
( THERMO-ALCOHOLOMETERS )

*(First Revision)*

UDC 542.3 : 531.756.3 : 536.51

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BUREAU OF INDIAN STANDARDS  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

*Indian Standard*  
**SPECIFICATION FOR**  
**GLASS ALCOHOLOMETERS**

**PART 2 GLASS ALCOHOLOMETERS WITH THERMOMETER**  
**( THERMO-ALCOHOLOMETERS )**

*( First Revision )*

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*Indian Standard*  
**SPECIFICATION FOR  
GLASS ALCOHOLOMETERS**

**PART 2 GLASS ALCOHOLOMETERS WITH THERMOMETER  
( THERMO-ALCOHOLOMETERS )**

*( First Revision )*

**0. FOREWORD**

**0.1** This Indian Standard ( Part 2 ) ( First Revision ) was adopted by the Indian Standards Institution on 1 January 1987, after the draft finalized by the Laboratoryware and Related Apparatus Sectional Committee had been approved by the Chemical Division Council.

**0.2** This standard was originally published as IS : 3608-1966\* covering alcoholometers without thermometer. Subsequently, International Organization for Standardization ( ISO ) brought out the following standards:

ISO 4801-1979 Glass alcoholometers and alcohol hydrometers not incorporating a thermometer

ISO 4805-1982 Laboratory glassware — Thermo-alcoholometers and alcohol-thermo-hydrometers

The Committee responsible for the preparation of this standard decided to revise IS : 3608-1966\* in order to align this standard with the above ISO Standards. Accordingly, this standard has now been revised in two parts: Part 1 glass alcoholometers without thermometer; and Part 2 glass alcoholometers with thermometer.

**0.3** In this revision, the alcoholometers having 0·2° graduation ( type B ) have been omitted as the same are not in use. Instead two classes of accuracy have been introduced for glass alcoholometers without thermometer; class A for more accurate work and class B for normal work. Alcoholometer with thermometer has also been included. However, in the case of alcoholometer with thermometer only one type of accuracy, namely, class B, has been prescribed. Modifications in dimensions of alcoholometers have been made. Reference temperature has also been changed from 15 to 20°C in order to align with the international practice.

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\*Specification for glass alcoholometers.

## **IS : 3608 ( Part 2 ) - 1987**

**0.4** This standard contains **8.2** which calls for an agreement between the purchaser and the supplier.

**0.5** Besides the specifications for alcoholometers, the following two Indian Standards on alcoholometric tables have also been published:

IS : 2302-1962 Table for alcoholometry ( by centesimal hydrometers )

IS : 3506-1967 Tables for alcoholometry ( by pyknometer method )

These tables are presently based on reference temperature of 15°C. However, to fall in line with the international practice and to achieve utmost accuracy, these tables are being revised to 20°C reference temperature.

**0.6** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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### **1. SCOPE**

**1.1** This standard ( Part 2 ) prescribes the requirements and the methods of sampling and test for thermo-alcoholometers meant for determining the ethanol content in ethanol-water mixtures at 20°C.

**1.1.1** The basis of graduations of these alcoholometers are the values of density versus composition of ethanol solutions by volume as given in Table 1 of this standard and are based on values adopted by the International Organization of Legal Metrology ( OIML ).

### **2. TERMINOLOGY**

**2.0** For the purpose of this standard, the definitions given in IS : 1382-1981†, in addition to the following shall apply.

**2.1 Alcoholometer** — an instrument which indicates the alcoholic strength by volume of a mixture of water and ethanol.

**2.2 Bulb** — The wider portion of the alcoholometer containing the loading material.

**2.3 Ethanol Content ( at Temperature  $t^{\circ}\text{C}$  )** — The number of parts by volume of ethanol at 20°C contained in 100 parts by volume of the liquid at temperature  $t^{\circ}\text{C}$ .

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\*Rules for rounding off numerical values ( revised ).

†Glossary of terms relating to glass and glassware ( first revision ).

**2.4 Stem** — The thin tubing attached to the upper part of the bulb containing the indicating scale.

**2.5 Thermo-alcoholometer** — An instrument which indicates the alcoholic strength by volume of a mixture of water and ethanol and is provided with a built in thermometer.

**2.6 Observed Degree** — The percentage volume of ethanol of an alcoholic solution at temperature other than 20°C. The observed degree shall always be given with the temperature of the liquid.

**2.7 Observed Volume** — The volume of the liquid at the temperature at which it actually is the observed volume shall be expressed in litres at that particular temperature, for example, 1.025 3 litres at 25°C.

### **3. TEMPERATURE OF CALIBRATION AND RANGE OF SCALES**

**3.1 Temperature of Calibration** — The alcoholometers shall be calibrated at 20°C.

**3.2 Range of Scale** — The thermo-alcoholometers shall cover the entire range of 0 to 100°C in steps of 5 degrees on each thermo-alcoholometer. An additional thermo-alcoholometer may be provided to cover the range 98 to 103°.

NOTE — Alcoholic content more than 100 percent volumes are imaginary (*see Table 1*). These values are necessary for adjustment of alcoholometers in highly concentrated alcohol-water mixtures at temperature between 20 to 40°C, the density of which formally corresponds to alcohol content more than 100 percent.

### **4. BASIS OF SCALE**

**4.1** The basis of scale of each type of thermo-alcoholometer shall be the values of density versus composition of ethanol solutions by volume as given in Table 1.

### **5. SURFACE TENSION**

**5.1** In marking graduation lines, the conventional values given in Table 1 shall be assumed for the surface tension at 20°C of ethanol solutions of various concentrations.

### **6. REFERENCE LEVEL FOR READING**

**6.1** The thermo-alcoholometers shall be graduated for reading at the level of the free horizontal surface of the liquid.

### **7. REQUIREMENTS**

**7.0** Thermo-alcoholometers shall conform with the general requirements given in IS : 9621-1980\*.

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\*Principles of construction and adjustment of glass hydrometers.

**TABLE 1 ETHANOL CONTENT BY VOLUME, DENSITY AND SURFACE TENSION AT 20°C**  
*(Clauses 4.1 and 5.1)*

OBSERVED DEGREE PER- CENT VOLUME	DENSITY kg/m <sup>3</sup>	SURFACE TENSION mN/m	OBSERVED DEGREE PER- CENT VOLUME	DENSITY kg/m <sup>3</sup>	SURFACE TENSION mN/m	OBSERVED DEGREE PER- CENT VOLUME	DENSITY kg/m <sup>3</sup>	SURFACE TENSION mN/m
(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
0	998.20	72.6	35	955.59	33.3	70	885.56	26.7
1	996.70	68.1	36	954.15	32.9	71	883.06	26.6
2	995.23	64.5	37	952.69	32.6	72	880.54	26.5
3	993.81	61.7	38	951.18	32.3	73	877.99	26.4
4	992.41	59.6	39	949.63	31.9	74	875.40	26.3
5	991.06	57.8	40	948.05	31.7	75	872.79	26.2
6	989.73	56.1	41	946.42	31.4	76	870.15	26.1
7	988.43	54.5	42	944.76	31.1	77	867.48	25.9
8	987.16	53.1	43	943.06	30.9	78	864.78	25.8
9	985.92	51.8	44	941.32	30.6	79	862.04	25.7
10	984.71	50.5	45	939.54	30.4	80	859.27	25.6
11	983.52	49.4	46	937.73	30.2	81	856.46	25.4
12	982.35	48.3	47	935.88	30.0	82	853.62	25.3
13	981.21	47.2	48	934.00	29.8	83	850.74	25.2
14	980.08	46.3	49	932.09	29.6	84	847.82	25.0
15	978.97	45.4	50	930.14	29.4	85	844.85	24.9
16	977.87	44.5	51	928.16	29.3	86	841.84	24.8
17	976.79	43.7	52	926.16	29.1	87	838.77	24.6
18	975.71	42.9	53	924.12	28.9	88	835.64	24.5
19	974.63	42.1	54	922.06	28.8	89	832.45	24.4
20	973.56	41.4	55	919.96	28.6	90	829.18	24.2
21	972.48	40.7	56	917.84	28.5	91	825.83	24.1
22	971.40	40.0	57	915.70	28.3	92	822.39	23.9
23	970.31	39.3	58	913.53	28.2	93	818.85	23.8
24	969.21	38.7	59	911.33	28.1	94	815.18	23.6
25	968.10	38.1	60	909.11	27.9	95	811.38	23.4
26	966.97	37.5	61	906.87	27.8	96	807.42	23.3
27	965.81	37.0	62	904.60	27.7	97	803.27	23.1
28	964.64	36.4	63	902.31	27.6	98	798.90	22.9
29	963.44	35.9	64	899.99	27.4	99	794.25	22.6
30	962.21	35.4	65	897.65	27.3	100	789.24	22.4
31	960.95	35.0	66	895.28	27.2	101	783.75	22.2
32	959.66	34.5	67	892.89	27.1	102	778.26	22.0
33	958.34	34.1	68	890.48	27.0	103	772.77	21.8
34	956.98	33.7	69	888.03	26.9			

## 7.1 Materials

**7.1.1 Glass** — The thermo-alcoholometers shall be made of colourless transparent glass, resistant to chemicals and thermal shock encountered in use. It shall be as free as possible from strain and visual defects.

**7.1.1.1** The coefficient of cubical thermal expansion of glass shall be  $(25 \pm 2) \times 10^{-6}$  per degree celsius.

**7.1.2 Loading Material** — The loading material shall be confined to the bottom of the bulb. After the instrument has been maintained in a horizontal position for 1 hour at 80°C and subsequently cooled in that position, it shall meet the requirements of 7.2.

NOTE — The use of mercury as loading material is not permitted for alcoholometer only.

**7.1.2.1** There shall be no loose material whatsoever in any part of the instrument.

**7.2 Pattern Workmanship and Finish** — The thermo-alcoholometers shall be of a pattern as shown in Fig. 1.

**7.2.1** It shall be circular in cross-section, robust and symmetrical about the main axis. It shall float vertically in alcoholic solutions of appropriate strength and the inclination, if any, from the vertical, shall not exceed 1.5 degrees.

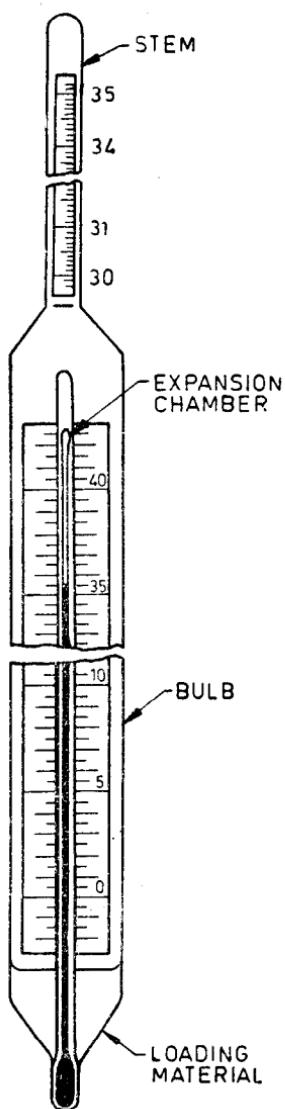
**7.3 Thermometer Scale** — In thermo-alcoholometers, the thermometer shall conform with the design requirements given in IS : 8787-1977\* and those given in Table 2.

**TABLE 2 REQUIREMENTS FOR THERMOMETER FOR  
THERMO-ALCOHOLOMETER**

SL No.	CHARACTERISTIC	REQUIREMENT
(1)	(2)	(3)
i)	Range of thermometer	0 to 40°C
ii)	Immersion	total
iii)	Subdivision 1	0.5°C
iv)	Scale error at any point	± 0.2°C
v)	Scale length, Min	80 mm
vi)	Extension of scale on either side	4 graduations
vii)	Expansion chamber to withstand temperature rise up to, Min	80°C

NOTE — The bulb of the thermometer should form an integral part of alcoholometer.

\*Principles of design, construction and use of liquid-in-glass thermometers.



**FIG. 1 GLASS ALCOHOLOMETER WITH THERMOMETER**

**7.4 Scale** — The scales and inscriptions shall be marked on a smooth matt surface of white or off-white colour. It shall be straight and free from twist. Neither the scale nor the graduations shall distort or discolour when the alcoholometer is maintained at a temperature of 80°C for 24 hours. The thermo-alcoholometer scale shall be fully enclosed in the thermo-alcoholometer with all graduation marks clearly visible on the stem.

**7.4.1** A reference mark consisting of a short horizontal straight line with a 'V' at each end, thus >—< shall be marked in the paper scale a few millimetres above the topmost graduation mark. A fine, clearly etched permanent line of uniform thickness shall be etched on the stem of the thermo-alcoholometer coincident with the horizontal portion of the reference mark and slightly longer than that portion of the reference marks so that the ends of the etched line project into the 'Vs' at the ends of the reference mark.

**7.4.1.1** A suitable datum line shall be also marked for thermometer scale similar to the one given in **7.4.1**.

**7.4.1.2** The graduations of thermometer shall [be in accordance with **8.1** of IS : 8787-1977\*.

**7.4.2** The graduation lines shall be distinct and of uniform thickness not exceeding one fifth of the distance between the centres of adjacent graduation lines or 0.2 mm, whichever is less. There shall be no evident local irregularities in their spacing. They shall be perpendicular to the axis of the thermo-alcoholometer.

**7.4.3** The nominal range of each thermo-alcoholometer shall not exceed 5 degrees. Each thermo-alcoholometer shall carry two to ten additional graduation lines beyond the nominal limits at both ends of the scale.

**7.4.4** The long, medium and short graduation lines shall extend respectively to at least one half, one third and one fifth of the circumference of the stem.

**7.4.5 Sequence of Graduation Lines** — Every tenth graduation line shall be a long line. There shall be a medium line between two consecutive long lines and four short lines between consecutive medium and long lines.

**7.4.6 Figuring of Graduation Lines for Thermo-alcoholometer** — The highest and the lowest graduation lines referring to the nominal range of the

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\*Principles of design, construction and use of liquid-in-glass thermometers.

thermo-alcoholometer shall be figured in full. At least every long graduation line shall be figured. Graduation lines within the nominal range and the inscription shall be marked in black. Graduation lines outside the nominal range may be marked in colour other than black.

**7.4.6.1 Figuring of graduation lines for thermometer** — The figuring of thermometer shall be in accordance with 8.3 of IS : 8787-1977\*.

**7.5 Dimensions** — The dimensions shall be as given in Table 3.

**TABLE 3 DIMENSIONS FOR THERMO-ALCOHOLOMETERS**

SL No.	DIMENSIONS	VALUES
(1)	(2)	(3) mm
i)	Overall length, <i>Max</i>	335
ii)	Length of scale, <i>Min</i>	42.5
iii)	Sub-sub-division	0.1°
iv)	Stem diameter, <i>Min</i>	3
v)	Body diameter      } <i>Min</i> } <i>Max</i>	21 23

**7.5.1** The cross section of the stem shall remain unchanged for at least 5 mm below the lowest graduation line.

**7.5.2** The stem shall extend at least 15 mm above the uppermost graduation line on the scale.

**7.5.3** The volume of the bulb below the lowest graduation line shall be between 60 and 80 cm<sup>3</sup>.

**7.6 Accuracy** — The error at any point on the scale of thermo-alcoholometer shall not exceed  $\pm 1$  small division.

**7.6.1** The accuracy of the thermo-alcoholometers shall be tested in accordance with the procedure prescribed in Appendix A.

**7.6.2** The accuracy of the thermometer scale shall be tested in accordance with the method prescribed in IS : 6274-1971\*.

\*Principles of design, construction and use of liquid-in-glass thermometers.

\*Method of calibrating liquid-in-glass thermometers.

## 8. MARKING AND PACKING

**8.1 Marking** — Each thermo-alcoholometer shall be marked legibly and indelibly with the following information:

- a) Maker's name or recognized trade-mark, if any;
- b) The word thermo-alcoholometer;
- c) Calibration temperature, that is, 20°C;
- d) Identification mark; if any.

**8.1.1** The thermo-alcoholometers may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

**8.2 Packing** — The thermo-alcoholometers shall be securely packed as agreed to between the purchaser and the supplier.

## 9. SAMPLING

**9.1** The method of drawing representative samples of the thermo-alcoholometers and the criteria for conformity shall be as prescribed in Appendix B.

## A P P E N D I X A

( Clause 7.6.1 )

### METHOD OF TESTING ACCURACY OF THERMO-ALCOHOLOMETERS

#### A-1. GENERAL

**A-1.1** Checking of thermo-alcoholometers shall be done by one of the following methods:

- a) Comparison with a similar Standard Thermo-Alcoholometer (**A-2**); and
- b) Verifying the readings of thermo-alcoholometer at 20°C by determining the density of the liquid at the same temperature by pyknometer and then finding the observed degree corresponding to particular density from Table 1.

**A-2. COMPARISON METHOD**

**A-2.1** Readings of the liquid shall be as taken simultaneously with the thermo-alcoholometer under test and that with a similar but Standard Thermo-Alcoholometer under similar conditions. The readings shall be taken at four or five different points covering the entire range.

**A-2.2** The readings by thermo-alcoholometers shall be taken in a circular or preferably a rectangular vessel suitable for the thermo-alcoholometer. Dimensions of appropriate vessels are given in Table 4.

**TABLE 4 RECOMMENDED SIZES OF VESSELS****INTERNAL SIZE OF VESSEL**

Rectangular mm	Circular mm
$(135 \pm 5) \times (55 \pm 3) \times (430 \pm 5)$	$(125 \pm 5) \times (430 \pm 5)$

**A-3. VERIFICATION BY PYKNOMETER**

**A-3.1** A suitable pyknometer of 25 ml capacity, such as shown in Fig. 2 or pyknometer Type 3 of IS : 5717-1970\* shall be used. The determination shall be carried out at 20°C.

**A-3.2** Pour the liquid under test in a weighed pyknometer taking due care that no air is entrapped. Allow the level of the liquid to rise slightly above the mark on the neck of the pyknometer. Place the pyknometer in a bath so that it is immersed in the bath up to a height slightly below the mark. Maintain the bath at 20°C for about half-an-hour so that the liquid and the pyknometer acquire the temperature of the bath. Adjust the liquid level such that the meniscus just touches the mark on the neck of the pyknometer. Remove the pyknometer from the bath, wipe, dry and weigh; and determine the mass of the liquid.

**A-3.3** The true mass of the liquid is calculated by adding to the observed mass of the liquid a correction for the buoyancy effect of the air. This correction is calculated from the following formula:

$$C = P(V - m/d)$$

where

$C$  = correction factor,

$P$  = density of air at the temperature of experiment,

$V$  = volume in ml of liquid in the pyknometer at 20°C,

\*Specification for pyknometers.

$m$  = observed mass in g of the liquid, and

$d$  = density of the material of weights at the temperature of experiment.

**A-3.4** Calculate the density of the liquid at 20°C by dividing the mass ( $m$ ) of the liquid as obtained above by volume ( $v$ ) at 20°C and subsequently find out corresponding degree from Table 1. Any departure from this value in the reading of thermo-alcoholometer for the same solution at 20°C separately shall be taken as error at the corresponding point on the scale.

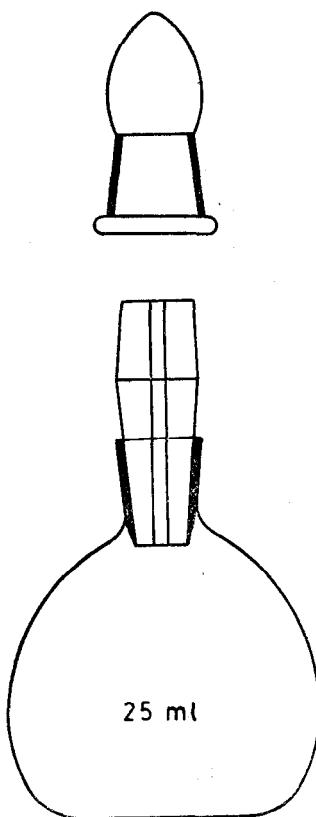


FIG. 2 PYKNOMETER

**A P P E N D I X B**

(Clause 9.1)

**SAMPLING SCHEME FOR GLASS ALCOHOLOMETERS  
WITH THERMOMETER****B-1. SCALE OF SAMPLING**

**B-1.1 Lot** — All the alcoholometers with thermometers of one type and range shall constitute one lot.

**B-1.2** Samples shall be taken from each lot for ascertaining the conformity to this specification and shall be according to Table 5.

**TABLE 5 NUMBER OF ALCOHOLOMETERS ( WITH THERMOMETERS )  
TO BE SELECTED**

LOT SIZE	SAMPLE SIZE	ACCEPTANCE NUMBER
(1)	(2)	(3)
Up to 15	2	0
16 to 25	3	0
26 to 50	5	0
51 to 100	8	1
101 and above	13	2

**B-1.2.1** The sample shall be selected from the lot at random and in order to ensure the randomness of selection, the method given in IS : 4905-1968\* may be followed.

**B-2. CRITERIA FOR CONFORMITY**

**B-2.1** The samples selected according to col 2 of Table 5 shall be tested for the requirements given in **7.2**, **7.4** and **7.6**. The lot shall be declared as conforming to these requirements if all the alcoholometers with thermometers satisfy these requirements.

**B-2.2** When the lot has been accepted with respect to the requirements of **7.2**, **7.4** and **7.6**, the test for other requirements given in **7** shall be done on the samples selected. If an alcoholometer with thermometers fails to satisfy any of the requirements given in **7**, it shall be declared as defective. The lot shall be declared as conforming to the requirements of **7** if the number of defectives in the lot does not exceed the corresponding acceptance numbers given in col 3 of Table 5.

\*Methods for random sampling.

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